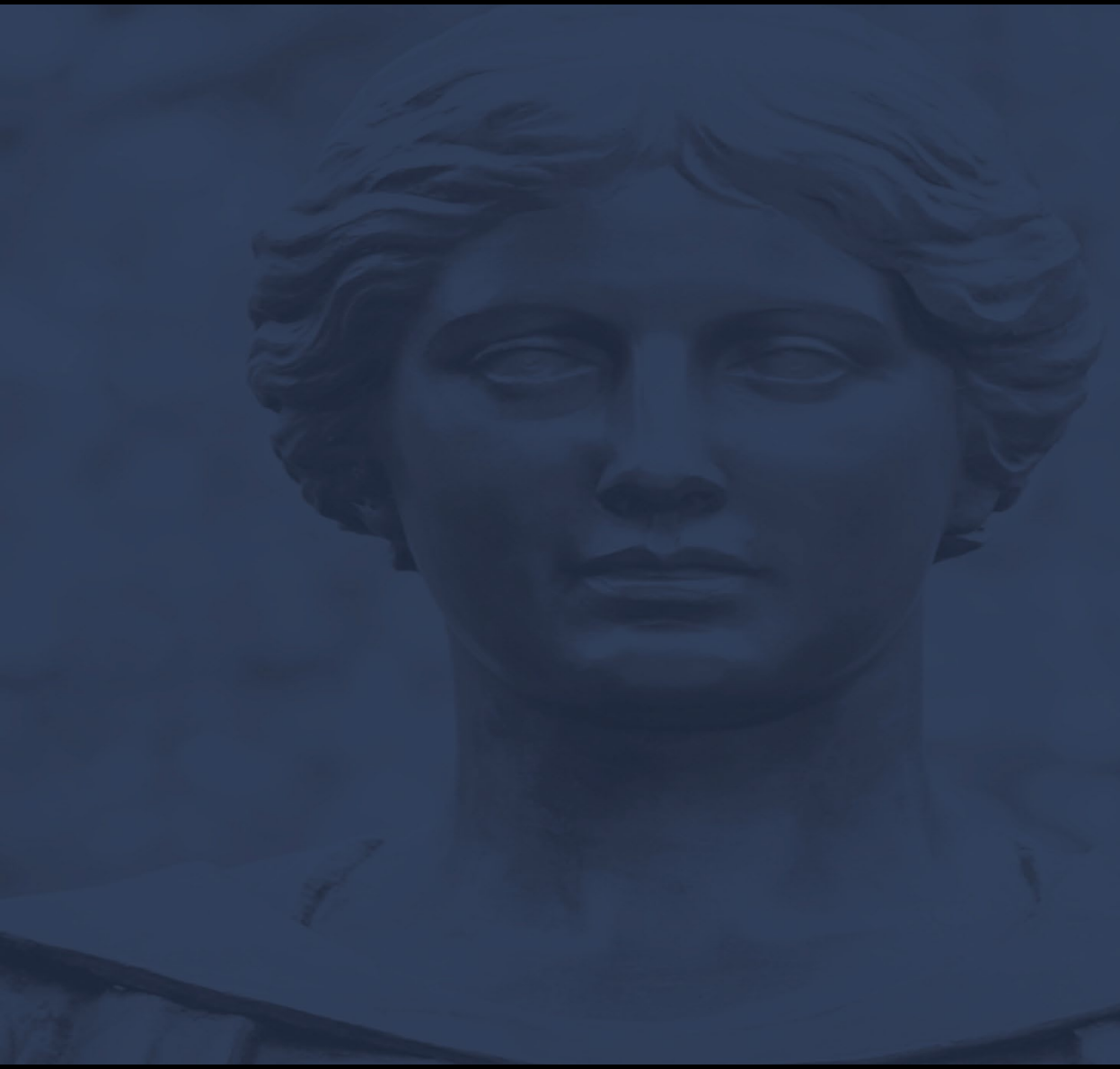
ILLINOIS



Machine Learning in Material Design

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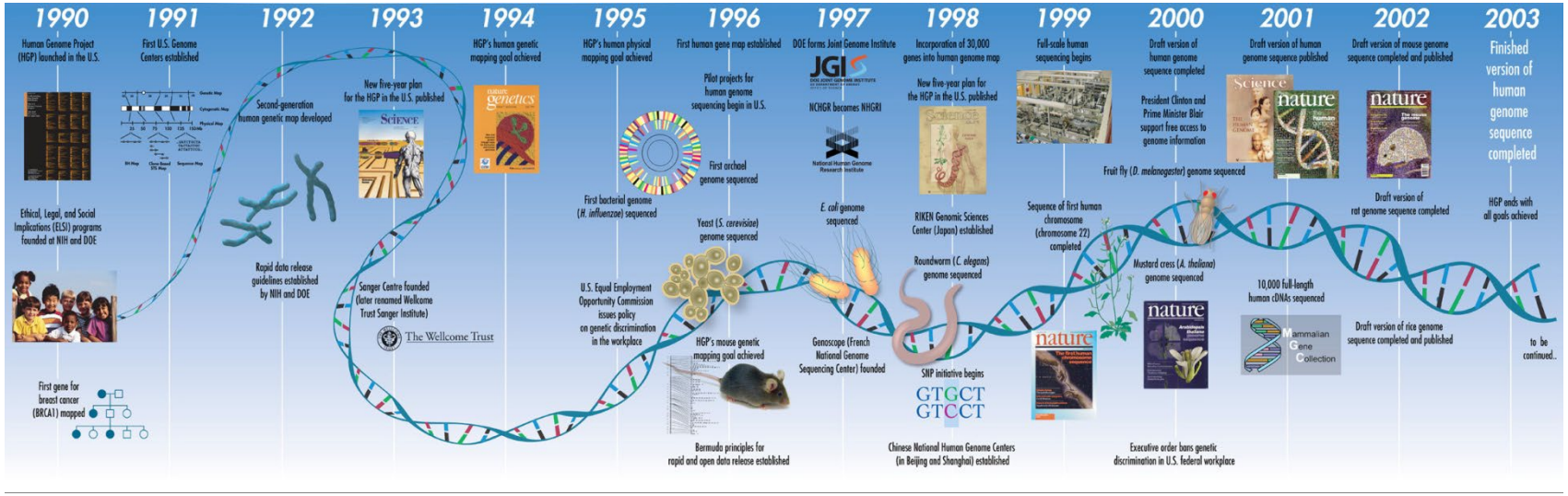
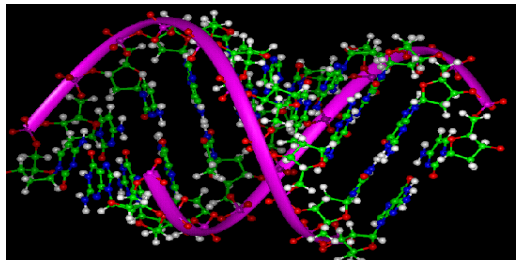
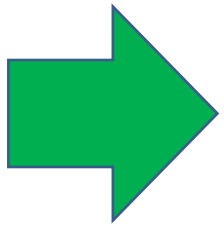
Human Genome Project for Wellbeing


1990
Human Genome Project (HGP) launched in the U.S.
Ethical, Legal, and Social Implications (ELSI) programs founded at NIH and DOE
First gene for breast cancer (BRCA1) mapped
1991
First U.S. Genome Centers established
1992
Second-generation human genetic map developed
Rapid data release guidelines established by NIH and DOE
1993
New five-year plan for the HGP in the U.S. published
Sanger Centre founded (later renamed Wellcome Trust Sanger Institute)
The Wellcome Trust
1994
HGP's human genetic mapping goal achieved
1995
HGP's human physical mapping goal achieved
First bacterial genome (H. influenzae) sequenced
U.S. Equal Employment Opportunity Commission issues policy on genetic discrimination in the workplace
1996
First human gene map established
Pilot projects for human genome sequencing begin in U.S.
First archael genome sequenced
Yeast (S. cerevisiae) genome sequenced
HGP's mouse genetic mapping goal achieved
Bermuda principles for rapid and open data release established
1997
DOE forms Joint Genome Institute
NCHGR becomes NHGRI
E. coli genome sequenced
Genoscope (French National Genome Sequencing Center) founded
1998
Incorporation of 30,000 genes into human genome map
New five-year plan for the HGP in the U.S. published
RIKEN Genomic Sciences Center (Japan) established
Roundworm (C. elegans) genome sequenced
SNP initiative begins
GTGCT
GTCCT
Chinese National Human Genome Centers (in Beijing and Shanghai) established
1999
Full-scale human sequencing begins
Sequence of first human chromosome (chromosome 22) completed
2000
Draft version of human genome sequence completed
President Clinton and Prime Minister Blair support free access to genome information
Fruit fly (D. melanogaster) genome sequenced
Mustard cress (A. thaliana) genome sequenced
Executive order bans genetic discrimination in U.S. federal workplace
2001
Draft version of human genome sequence published
10,000 full-length human cDNAs sequenced
2002
Draft version of mouse genome sequence completed and published
Draft version of rat genome sequence completed
Draft version of rice genome sequence completed and published
2003
Finished version of human genome sequence completed
HGP ends with all goals achieved
to be continued..



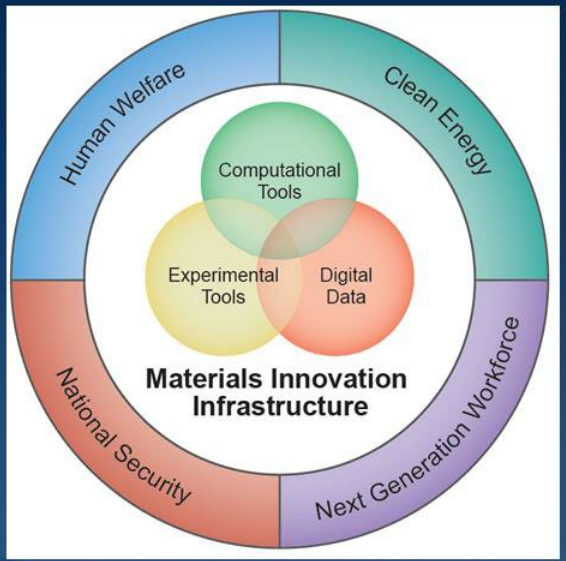


Materials Genome Initiative

The Materials Genome Initiative

Goal: to decrease the time-to-market for advanced materials by over 50%

- Develop an **innovation infrastructure** for materials deployment
- Achieve **National goals** in energy, security, and human welfare
- Prepare the **next generation workforce**



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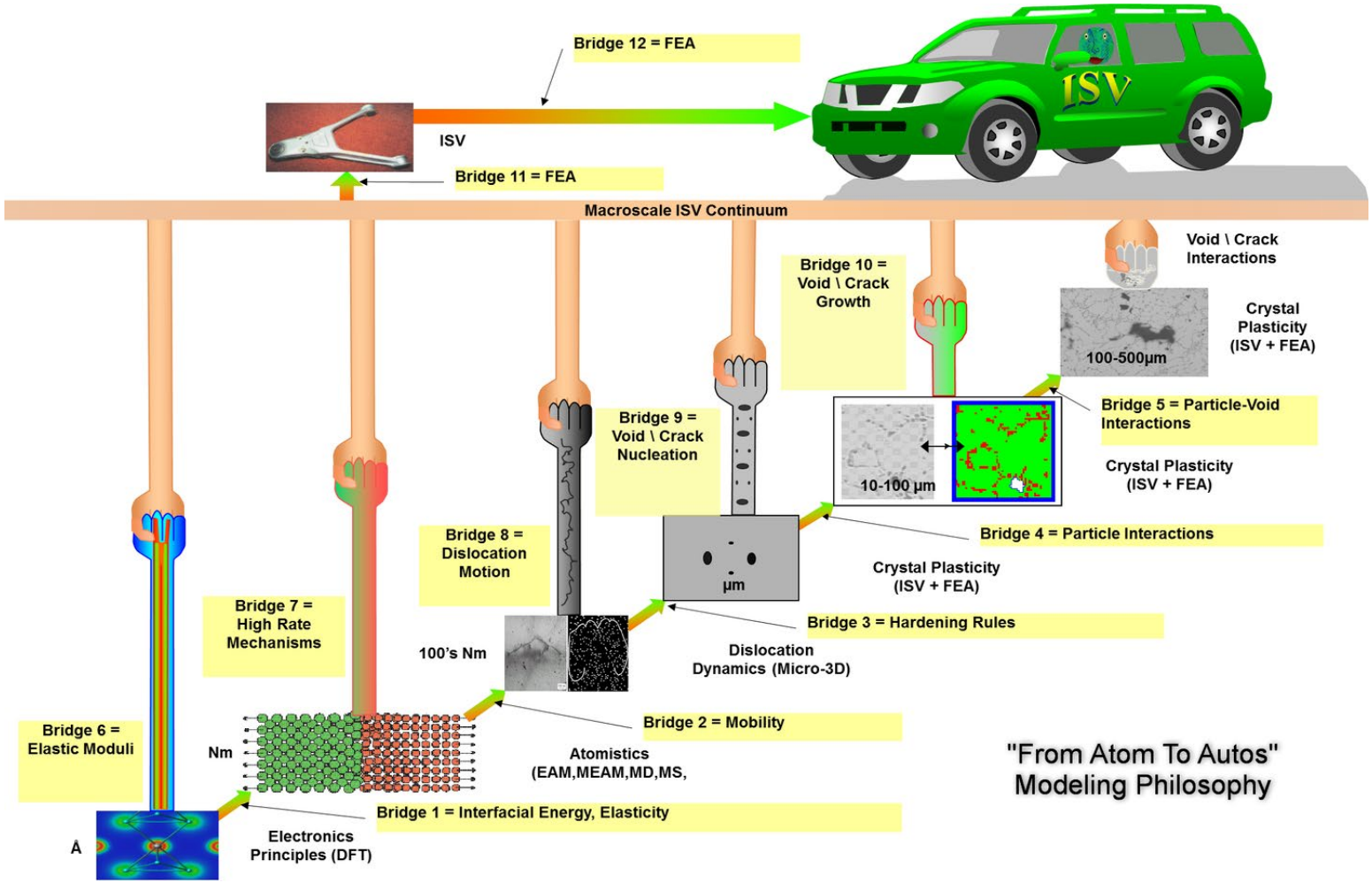
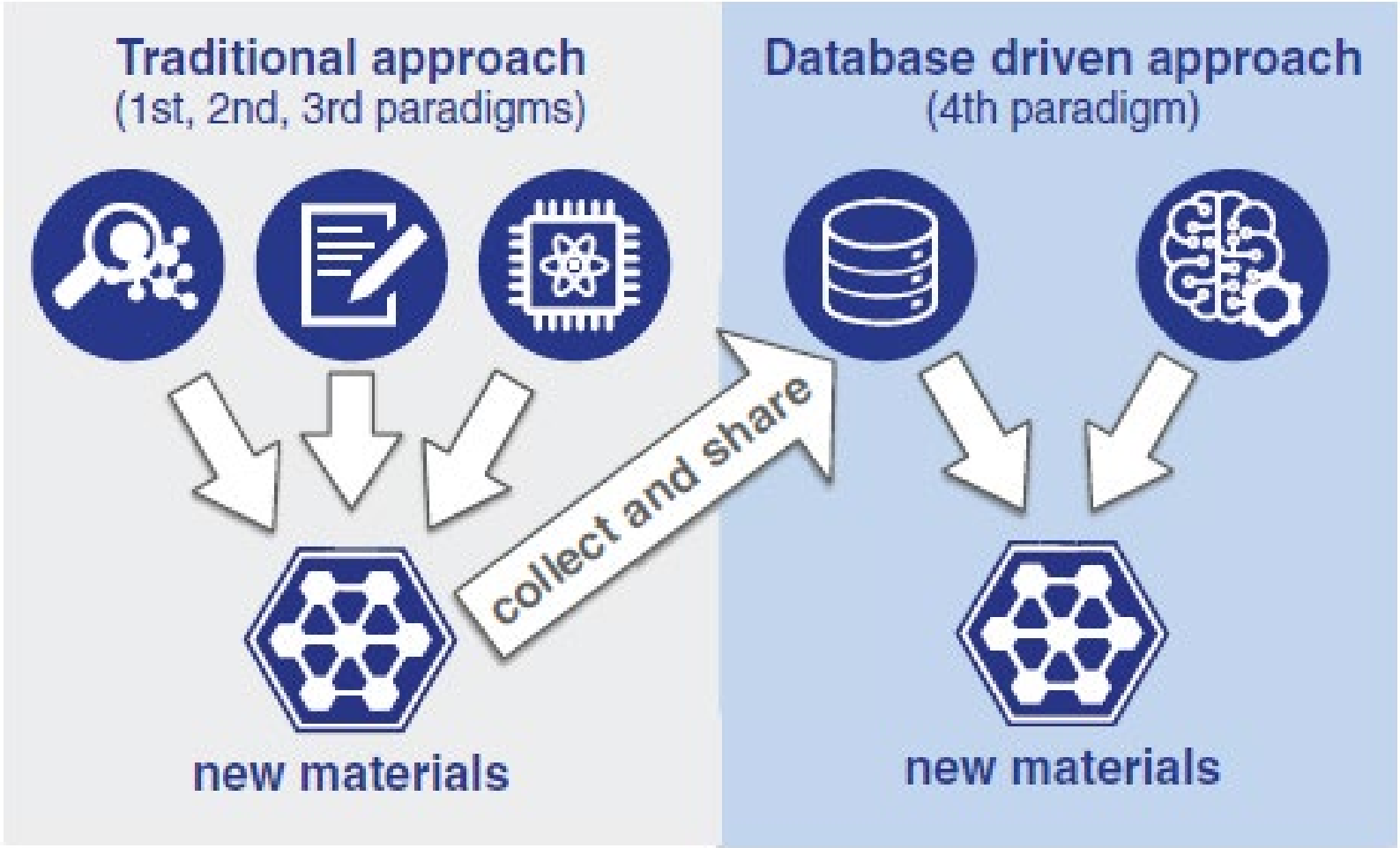
Initiatives to accelerate material discovery



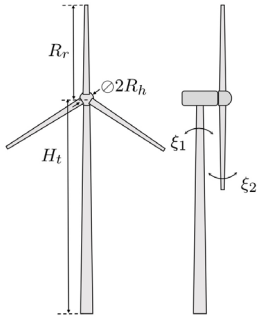
Data-driven Material Design

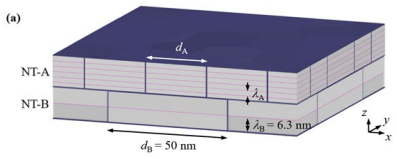


Engineering Design

Engineering Analysis

System description





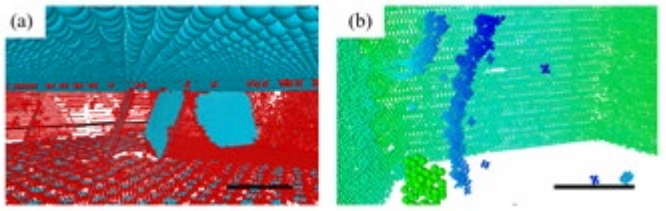
$[G_d^1, G_\lambda^1]$
$\vdots$
$[G_d^N, G_\lambda^N]$

System analysis

$$P_w(v) = \frac{1}{2} C_P(\lambda, \beta) \rho \pi R_r{}^2 v^3$$

$$\mathbf{C}(\mathbf{q}, t)\ddot{\mathbf{q}} + \mathbf{f}(\dot{\mathbf{q}}, \mathbf{q}, t) = \mathbf{0}$$

$$J_t \dot{\Omega}_r(t) = \Gamma_r(t) - B_t \Omega_r(t) - \eta \Gamma_g(t)$$



System behavior and performance

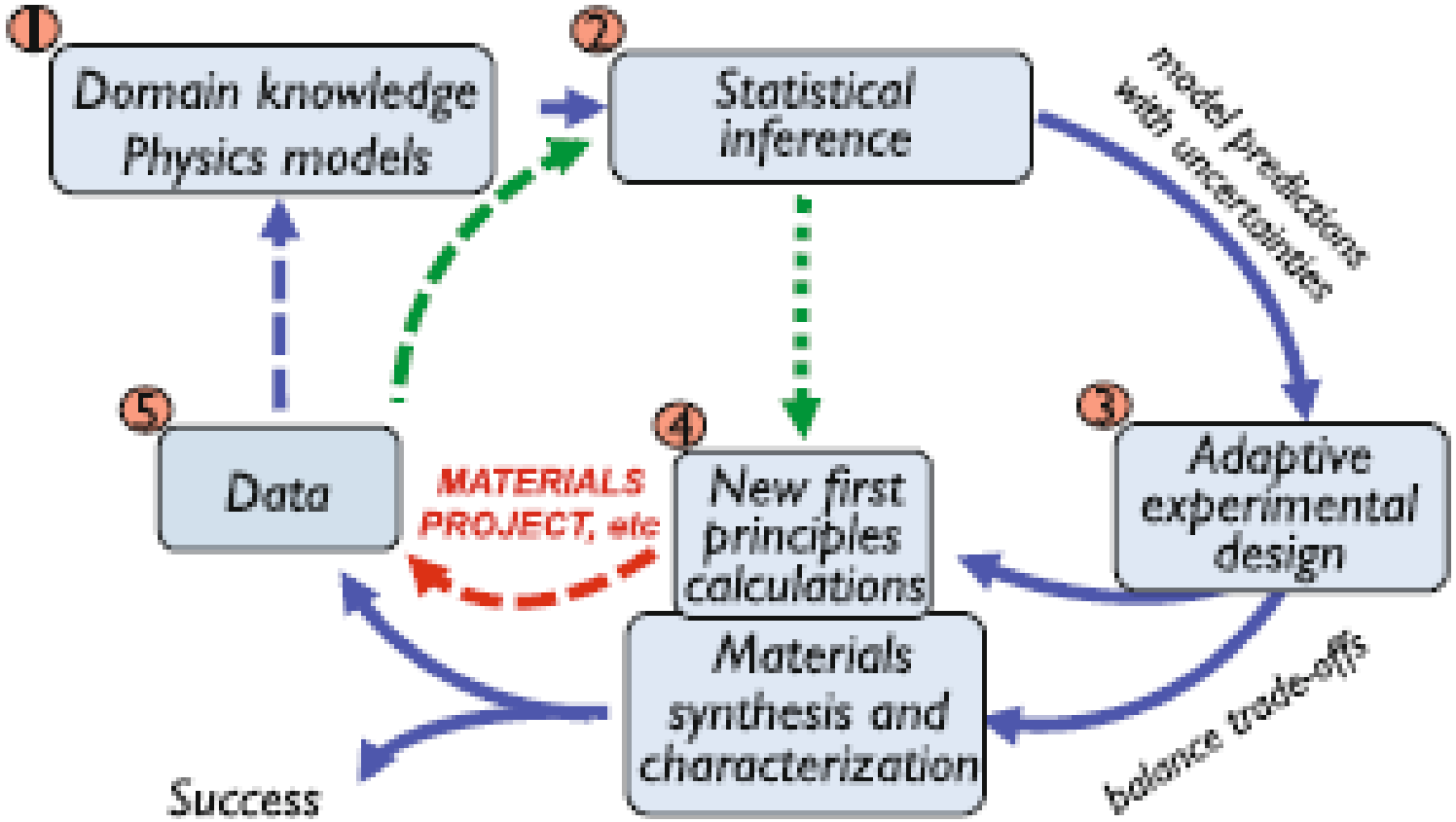
- **Cost**

(total cost of energy)

- **Capacity**
- **Properties**
- **Reliability**
- **Manufacturability**
- **Other performance metrics**

Engineering Design

New Material research



Topics

- Data and databases
- Physics-informed machine learning
- Representation and feature analysis
- Model validation and uncertainty quantification
- Adaptive learning
- Explainable machine learning

Homework and term project

- No homework

- Term project

  There will be one term project. It is an individual project. You can choose the research question to work on. The research topic should be narrow enough to explore in depth. It needs to be approved the instructor. Project presentations will be hold towards the end of semester